

What is claimed is:

1. A silicon optoelectronic device, comprising:
 - an n- or p-type silicon-based substrate;
 - a doped region, formed on a first surface of the substrate and doped to be an opposite type from that of the substrate, the doped region providing photoelectrical conversion;
 - a light-emitting device section formed on the first surface of the substrate; and
 - a light-receiving device section formed on the first surface of the substrate, wherein the light-emitting device section and the light-receiving device section use the doped region in common for photoelectrical conversion.
2. The silicon optoelectronic device as claimed in claim 1, wherein the light-emitting device section has a gate turn off (GTO) thyristor structure.
3. The silicon optoelectronic device as claimed in claim 2, wherein the light-emitting device section includes:
 - a first semiconductor material region, separate from the doped region and formed to a deeper depth than the doped region in the first surface of the substrate, the first semiconductor material region doped to be an opposite type from that of the substrate;
 - a second semiconductor material region, adjacent to the first semiconductor material region and formed in the surface of the substrate, the second semiconductor material region doped to be an opposite type from that of the first semiconductor material region; and
 - an electrode structure which supplies an electrical signal for controlling light emission,the electrode structure including:
 - a first electrode electrically connected to the doped region;

a second electrode electrically connected to the second semiconductor material region; and

a first gate electrode electrically connected to the first semiconductor material region.

4. The silicon optoelectronic device as claimed in claim 2, wherein the light-receiving device section includes:

a first semiconductor material region, separate from the doped region and formed to a deeper depth than the doped region in the surface of the substrate, a first semiconductor material region doped to be an opposite type from that of the substrate;

an oxide film, formed on the surface of the substrate and positioned between the first semiconductor material region and the doped region;

a first electrode formed on the first semiconductor material region;

and

a first gate electrode formed on the oxide film.

5. The silicon optoelectronic device as claimed in claim 2, wherein the light-receiving device section, the substrate and the doped region form a metal-oxide-semiconductor (MOS) transistor structure.

6. The silicon optoelectronic device as claimed in claim 2, further including a switching circuit, which selectively controls connection of a light emission power to the light-emitting device section and connection of at least one of a reverse bias power and a load resistance for light reception to the light-receiving device section.

7. The silicon optoelectronic device as claimed in claim 1, wherein the light-emitting device section includes:

a first semiconductor material region, separate from the doped region and formed to a deeper depth than the doped region in the first surface of

the substrate, the first semiconductor material region doped to be an opposite type from that of the substrate;

a second semiconductor material region, adjacent to the first semiconductor material region and formed in the surface of the substrate, the second semiconductor material region doped to be an opposite type from that of the first semiconductor material region; and

an electrode structure which supplies an electrical signal for controlling light emission,

the electrode structure including:

a first electrode electrically connected to the doped region;

a second electrode electrically connected to the second semiconductor material region; and

a first gate electrode electrically connected to the first semiconductor material region.

8. The silicon optoelectronic device as claimed in claim 7, wherein the light-receiving device section, the substrate and the doped region form an MOS transistor structure.

9. The silicon optoelectronic device as claimed in claim 1, wherein the light-receiving device section, the substrate and the doped region form an MOS transistor structure.

10. The silicon optoelectronic device as claimed in claim 9, wherein the light-receiving device section includes:

a third semiconductor material region, separate from the doped region and formed to a deeper depth than the doped region in the surface of the substrate, a first semiconductor material region doped to be an opposite type from that of the substrate;

an oxide film, formed on the first surface of the substrate and positioned between the third semiconductor material region and the doped region;

a third electrode formed on the third semiconductor material region;
and
a second gate electrode formed on the oxide film.

11. The silicon optoelectronic device as claimed in claim 9, further including a blocking region formed at a predetermined depth from the surface of the substrate around the doped region to block a leakage current.

12. The silicon optoelectronic device as claimed in claim 9, further including a switching circuit which selectively controls connection of a light emission power to the light-emitting device section and connection of at least one of a reverse bias power and a load resistance for light reception to the light-receiving device section.

13. The silicon optoelectronic device as claimed in claim 1, wherein the light-receiving device section includes:

a first semiconductor material region, separate from the doped region and formed to a deeper depth than the doped region in the surface of the substrate, a first semiconductor material region doped to be an opposite type from that of the substrate;

an oxide film formed on the surface of the substrate and positioned between the first semiconductor material region and the doped region;

a first electrode formed on the first semiconductor material region;
and

a first gate electrode formed on the oxide film.

14. The silicon optoelectronic device as claimed in claim 1, wherein the doped region has a depth allowing realization of photoelectric conversion due to quantum confinement effect at a p-n junction between the doped region and the substrate.

15. The silicon optoelectronic device as claimed in claim 1, further including a switching circuit, which selectively controls connection of a light emission power to the light-emitting device section and connection of at least one of a reverse bias power and a load resistance for light reception to the light-receiving device section.

16. The silicon optoelectronic device as claimed in claim 15, wherein the switching circuit includes a first switch for selectively connecting the light emission power to the light-emitting device section; and a second switch for selectively connecting at least one of the reverse bias power and load resistance for light reception to the light-receiving device section, wherein the switching circuit is formed to operate as complementary logic such that when the first switch is turned on, the second switch is turned off, and when the second switch is turned on, the first switch is turned off.

17. The silicon optoelectronic device as claimed in claim 16, wherein the first and second switches are integrally formed on the substrate.

18. The silicon optoelectronic device as claimed in claim 17, wherein the substrate is a monocrystalline silicon wafer.

19. The silicon optoelectronic device as claimed in claim 15, further including a blocking region formed at a predetermined depth from the first surface of the substrate around the doped region to block a leakage current.

20. The silicon optoelectronic device as claimed in claim 1, further including a blocking region formed at a predetermined depth from the first surface of the substrate around the doped region to block a leakage current.

21. The silicon optoelectronic device as claimed in claim 20, wherein the blocking region is formed by an O₂ implantation process.

22. The silicon optoelectronic device as claimed in claim 1, wherein the substrate is a monocrystalline silicon wafer.

23. A optical transceiver, comprising:

a silicon optoelectronic device panel having an array of silicon optoelectronic devices capable of detecting and emitting an optical signal arranged in an n- or p-type silicon-based substrate; and

an electrode structure selectively controlling detection and emission of each of the silicon optoelectronic devices,

wherein each of the silicon optoelectronic devices includes:

a doped region, formed on a first surface of the substrate and doped to be an opposite type from that of the substrate, to provide photoelectrical conversion;

a light-emitting device section formed on the first surface of the substrate; and

a light-receiving device section formed on the first surface of the substrate, wherein the light-emitting device section and the light-receiving device section use the doped region in common for photoelectrical conversion.

24. The optical transceiver as claimed in claim 23, wherein the light-emitting device section has a GTO thyristor structure.

25. The optical transceiver as claimed in claim 24, wherein the light-emitting device section includes:

a first semiconductor material region, separate from the doped region and formed to a deeper depth than the doped region in the first surface of the substrate, the first semiconductor material region doped to be an opposite type from that of the substrate;

a second semiconductor material region, adjacent to the first semiconductor material region and formed in the surface of the substrate,

the second semiconductor material region doped to be an opposite type from that of the first semiconductor material region; and

an electrode structure which supplies an electrical signal for controlling light emission,

the electrode structure including:

a first electrode electrically connected to the doped region;

a second electrode electrically connected to the second semiconductor material region; and

a first gate electrode electrically connected to the first semiconductor material region.

26. The optical transceiver as claimed in claim 23, wherein the light-emitting device section includes:

a first semiconductor material region, separate from the doped region and formed to a deeper depth than the doped region in the first surface of the substrate, the first semiconductor material region doped to be an opposite type from that of the substrate;

a second semiconductor material region, adjacent to the first semiconductor material region and formed in the surface of the substrate, the second semiconductor material region doped to be an opposite type from that of the first semiconductor material region; and

an electrode structure which supplies an electrical signal for controlling light emission,

the electrode structure including:

a first electrode electrically connected to the doped region;

a second electrode electrically connected to the second semiconductor material region; and

a first gate electrode electrically connected to the first semiconductor material region.

27. The optical transceiver as claimed in claim 23, wherein the light-receiving device section, the substrate and the doped region form an MOS transistor structure.

28. The optical transceiver as claimed in claim 27, wherein the light-receiving device section includes:

a first semiconductor material region, separate from the doped region and formed to a deeper depth than the doped region in the surface of the substrate, a first semiconductor material region doped to be an opposite type from that of the substrate;

an oxide film, formed on the surface of the substrate and positioned between the first semiconductor material region and the doped region;

a first electrode formed on the first semiconductor material region;

and

a first gate electrode formed on the oxide film.

29. The optical transceiver as claimed in claim 23, wherein the light-receiving device section includes:

a first semiconductor material region, separate from the doped region and formed to a deeper depth than the doped region in the surface of the substrate, a first semiconductor material region doped to be an opposite type from that of the substrate;

an oxide film, formed on the surface of the substrate and positioned between the first semiconductor material region and the doped region;

a first electrode formed on the first semiconductor material region;

and

a first gate electrode formed on the oxide film.

30. The transceiver as claimed in claim 23, wherein the doped region is formed to a depth so that the silicon optoelectronic devices express the photoelectric conversion effect by the quantum confinement effect at a p-n junction between the doped region and the substrate.

31. The optical transceiver as claimed in claim 23, wherein each of the silicon optoelectronic devices further includes a switching circuit, which selectively controls connection of a light emission power to the light-emitting device section and connection of at least one of a reverse bias power and a load resistance for light reception to the light-receiving device section.

32. The optical transceiver as claimed in claim 31, wherein the switching circuit includes a first switch for selectively connecting the light emission power to the light-emitting device section; and a second switch for selectively connecting at least one of the reverse bias power and load resistance for light reception to the light-receiving device section, wherein the switching circuit is formed to operate as complementary logic such that when the first switch is turned on, the second switch is turned off, and when the second switch is turned on, the first switch is turned off.

33. The optical transceiver as claimed in claim 32, wherein the first and second switches are integrally formed on the substrate.

34. The optical transceiver as claimed in claim 31, wherein each of the silicon optoelectronic devices further includes a blocking region formed at a predetermined depth from the surface of the substrate around the doped region to block a leakage current.

35. The optical transceiver as claimed in claim 31, wherein the silicon optoelectronic device panel includes at least three silicon optoelectronic devices per each pixel and the optical transceiver processes images.

36. The optical transceiver as claimed in claim 23, wherein each of the silicon optoelectronic devices further includes a blocking region

formed at a predetermined depth from the surface of the substrate around the doped region to block a leakage current.

37. The optical transceiver as claimed in claim 23, wherein the substrate is a monocrystalline silicon wafer.

38. The optical transceiver as claimed in claim 23, wherein the silicon optoelectronic device panel includes a two-dimensional array of the silicon optoelectronic devices.

39. The optical transceiver as claimed in claim 38, wherein the silicon optoelectronic device panel includes at least three silicon optoelectronic devices per each pixel and the silicon optoelectronic devices corresponding to each pixel emit and receive light of different wavelengths to represent a color image.

40. The optical transceiver as claimed in claim 38, wherein the silicon optoelectronic device panel includes at least three silicon optoelectronic devices per each pixel and the optical transceiver further includes a color filter in front of the silicon optoelectronic device panel.

41. The optical transceiver as claimed in claim 38, wherein the optical transceiver is used to input information to a screen controlled by an optical wireless remote controller.